(No Model.)

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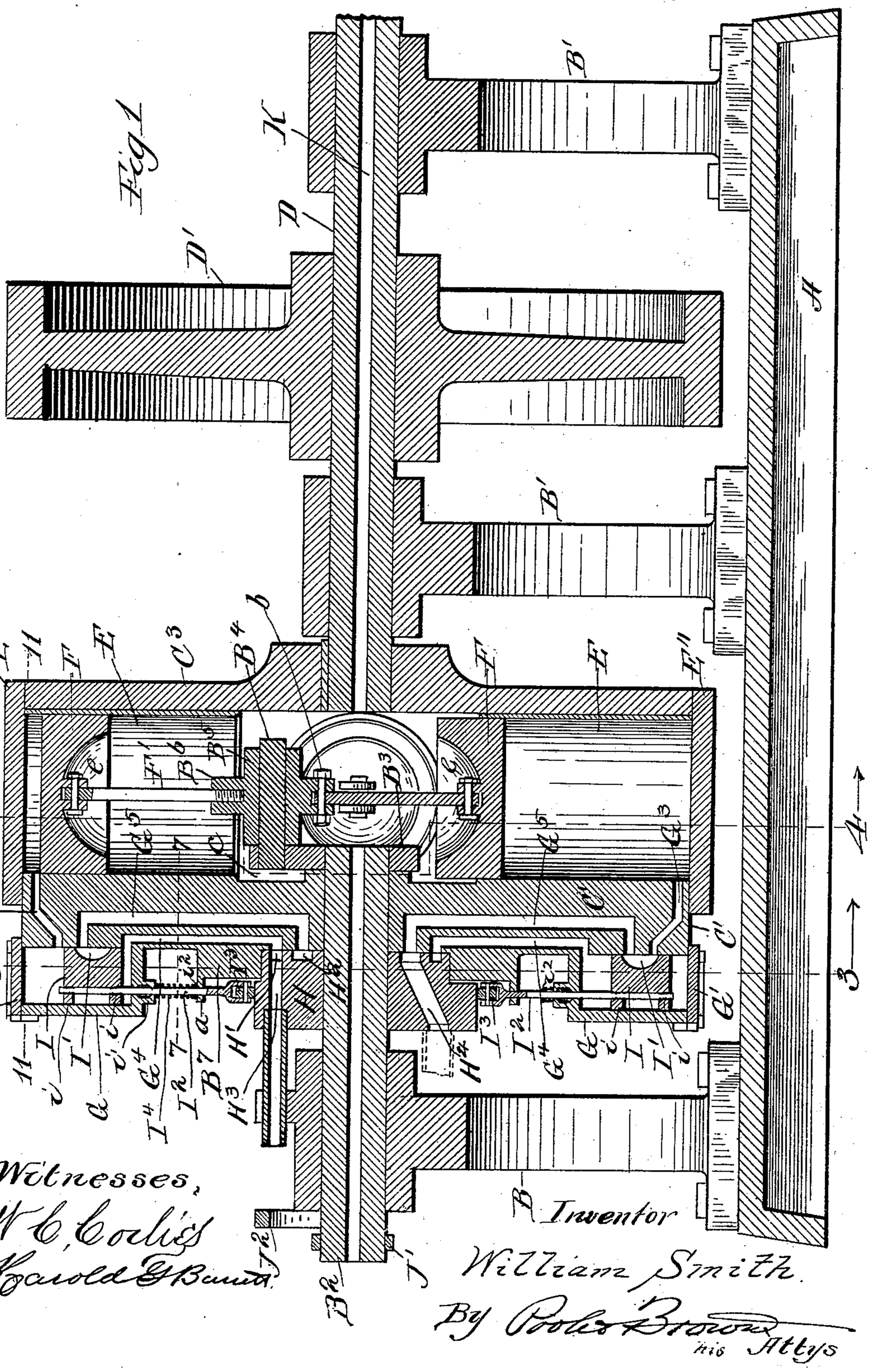
W. SMITH.

ROTARY ENGINE.

No. 602,630. Patented Apr. 19, 1898.

Fig 1.



Witnesses,
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(No Model.)

4 Sheets—Sheet 2.

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ROTARY ENGINE.

No. 602,630. Patented Apr. 19, 1898.

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(No Model.) 4 Sheets—Sheet 3.

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ROTARY ENGINE.

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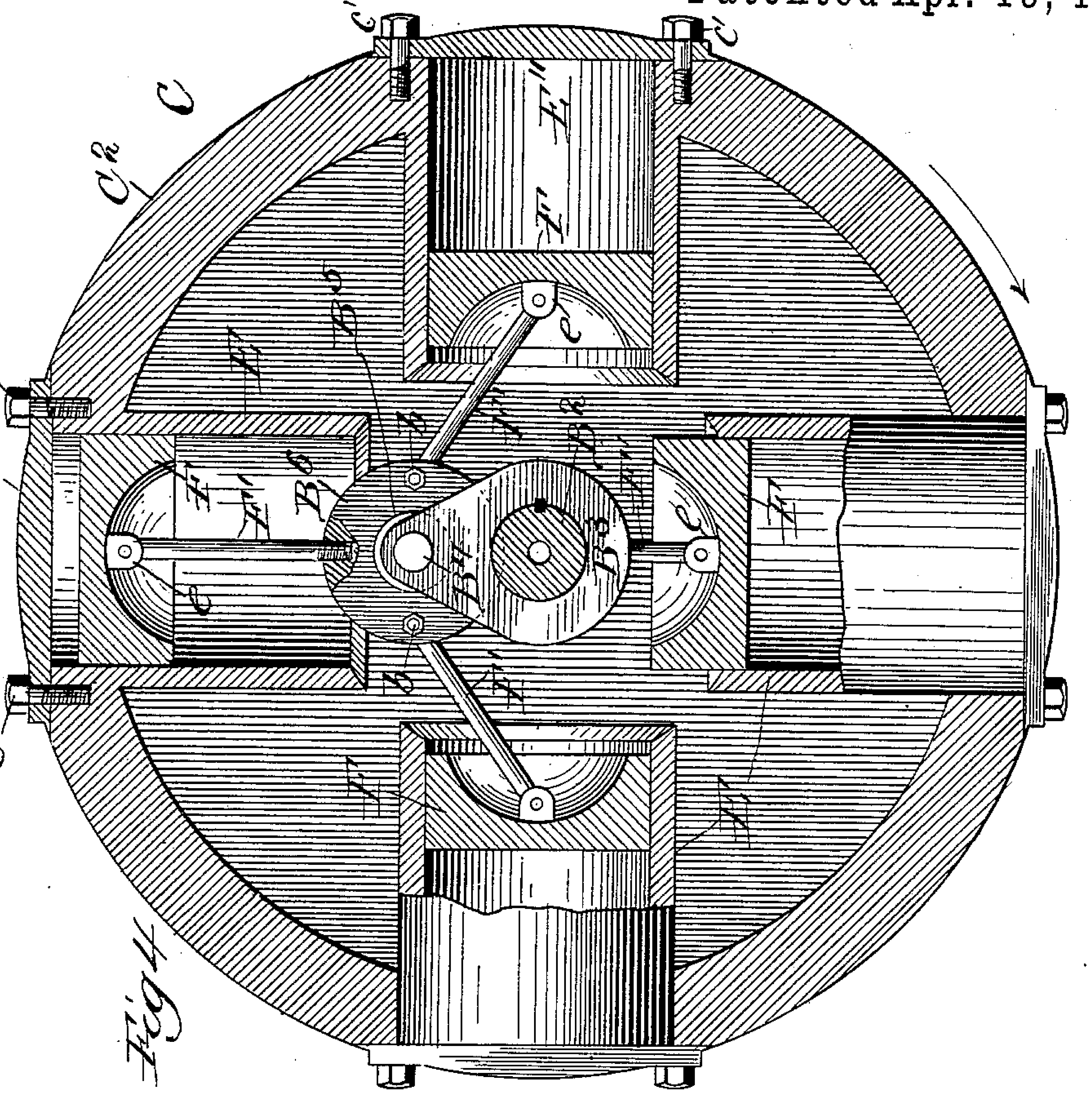

Fig. 4

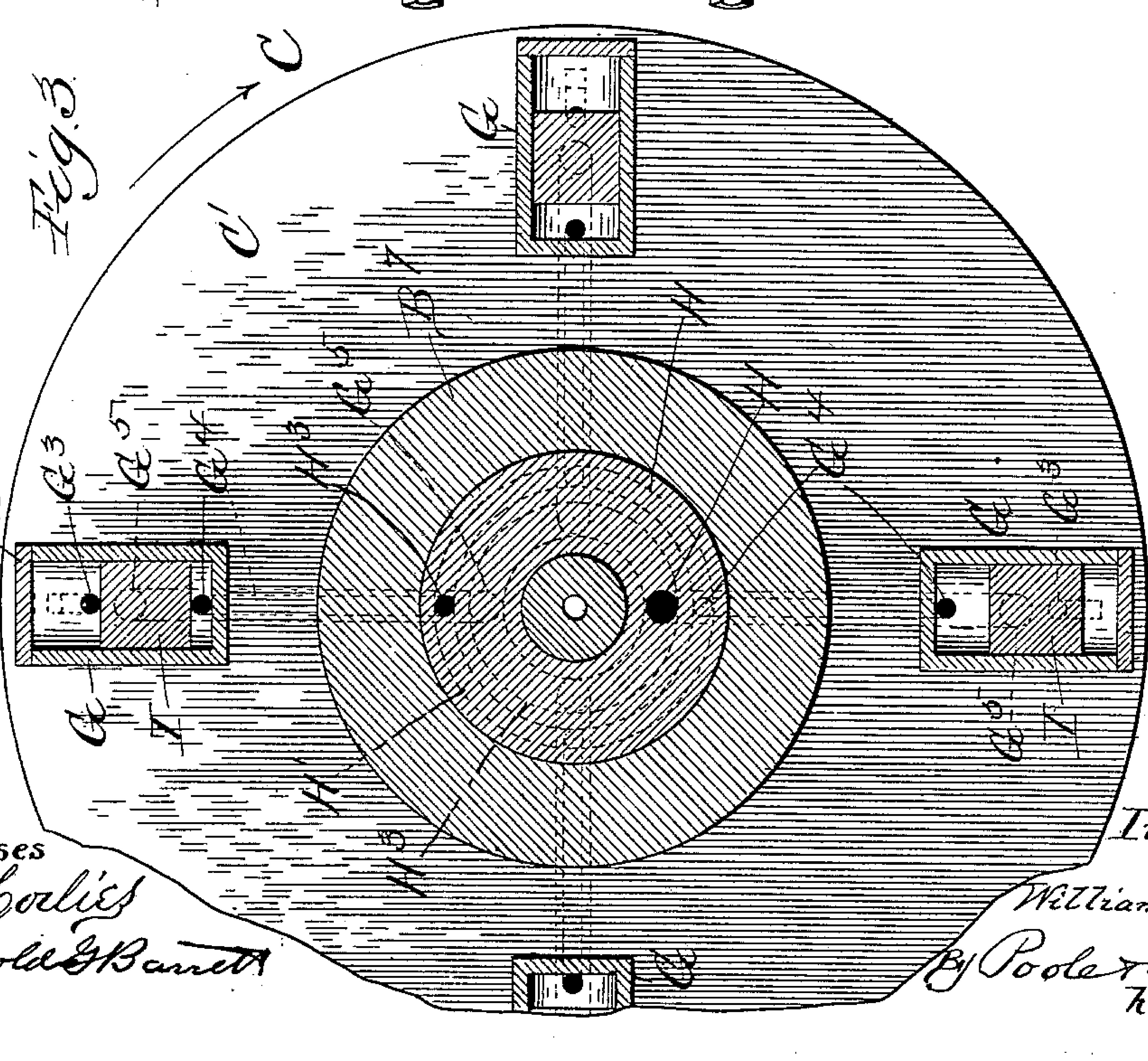

Fig. 3

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4 Sheets—Sheet 4.

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No. 602,630. Patented Apr. 19, 1898.

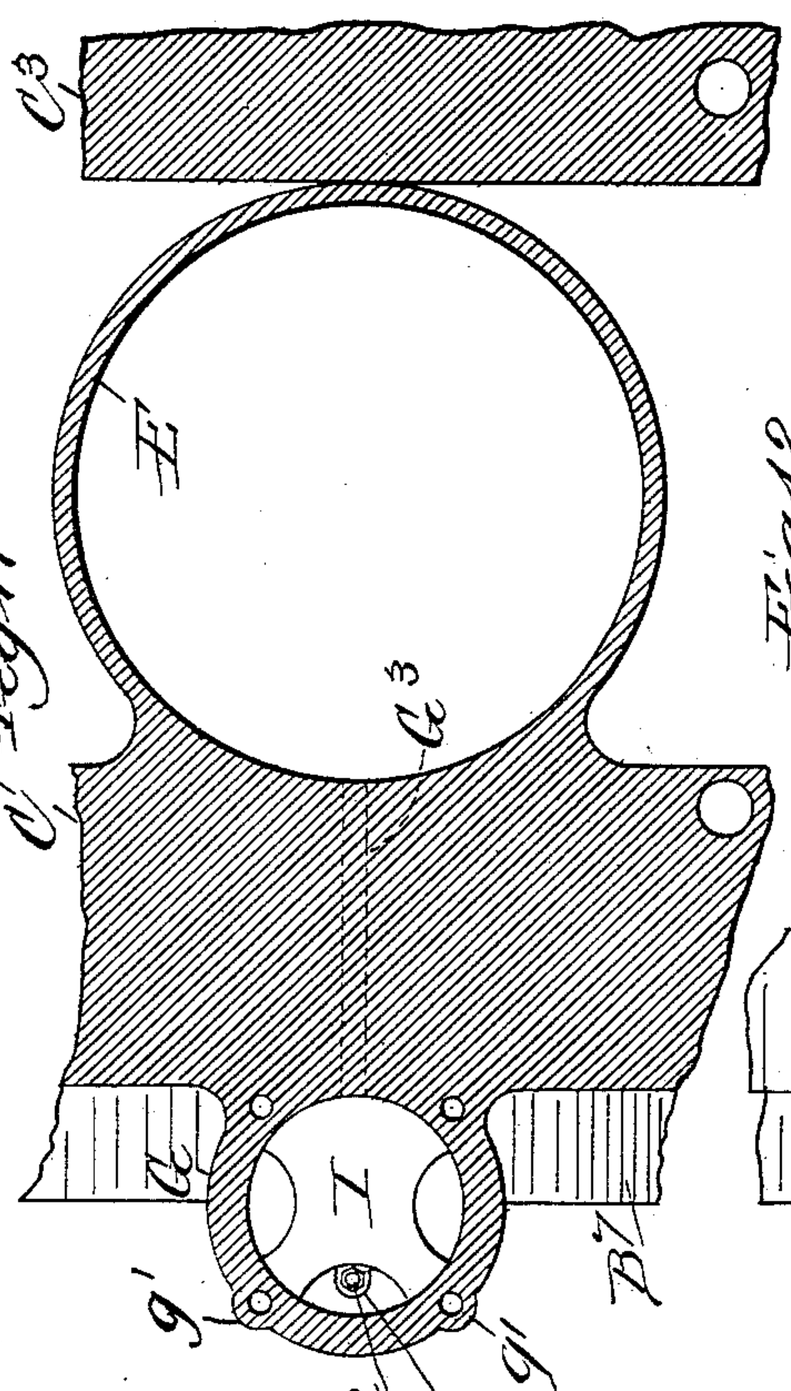

Fig. 11

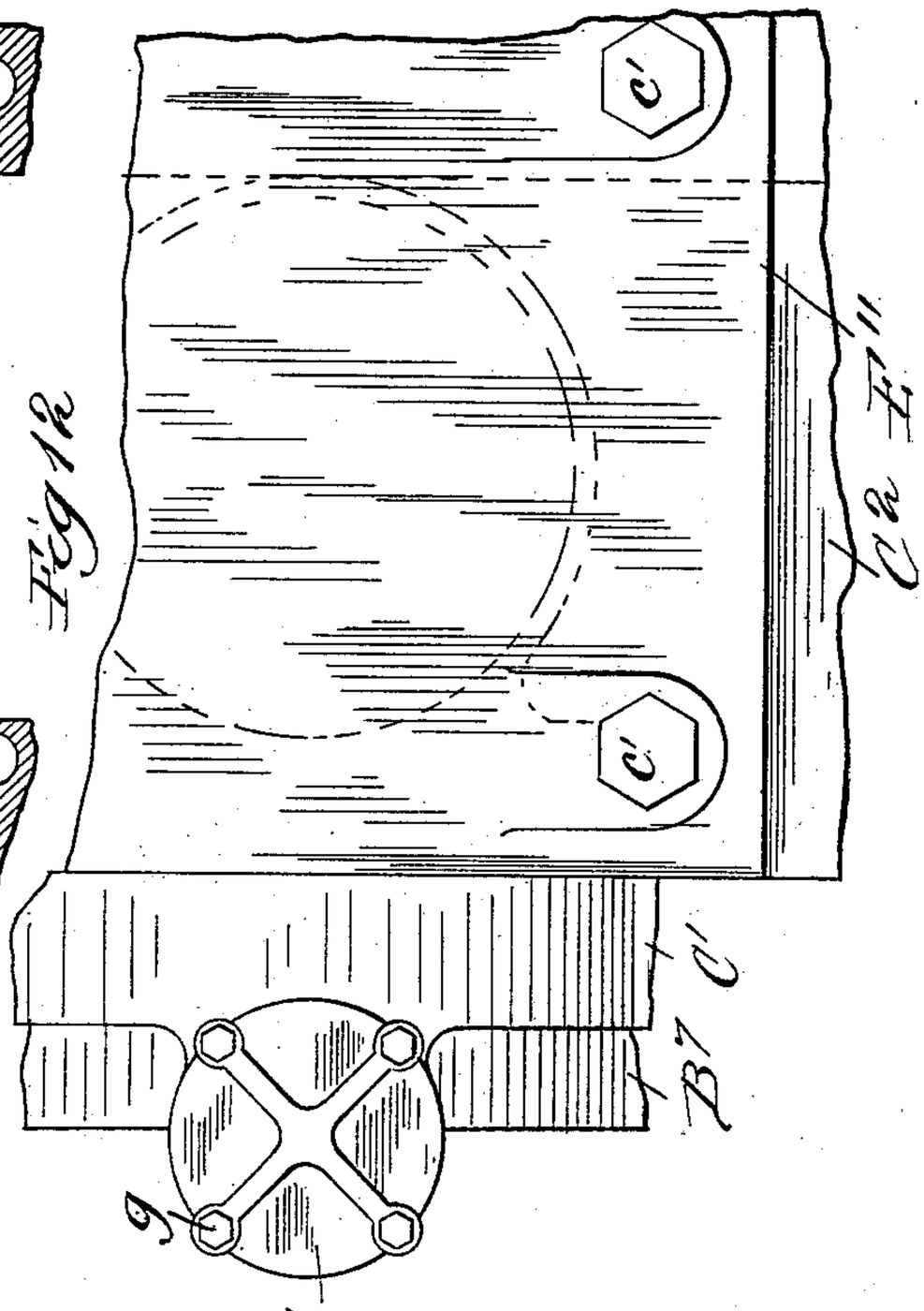

Fig. 12

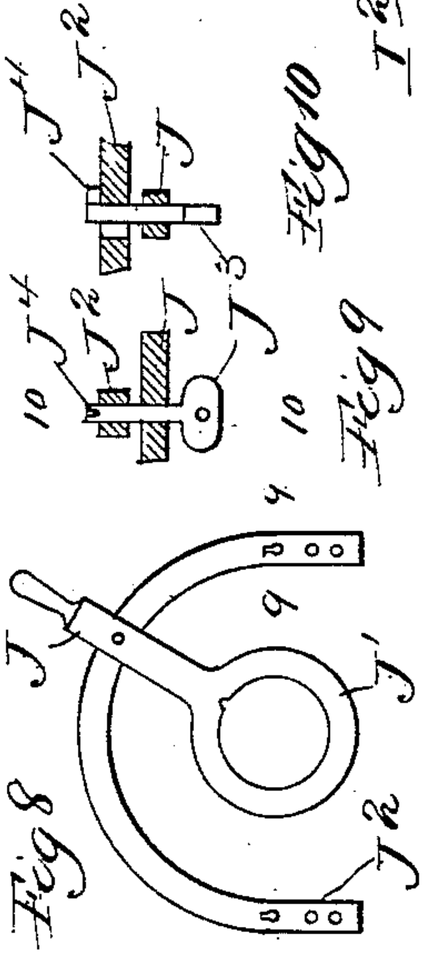

Fig. 8

Fig. 9

Fig. 10

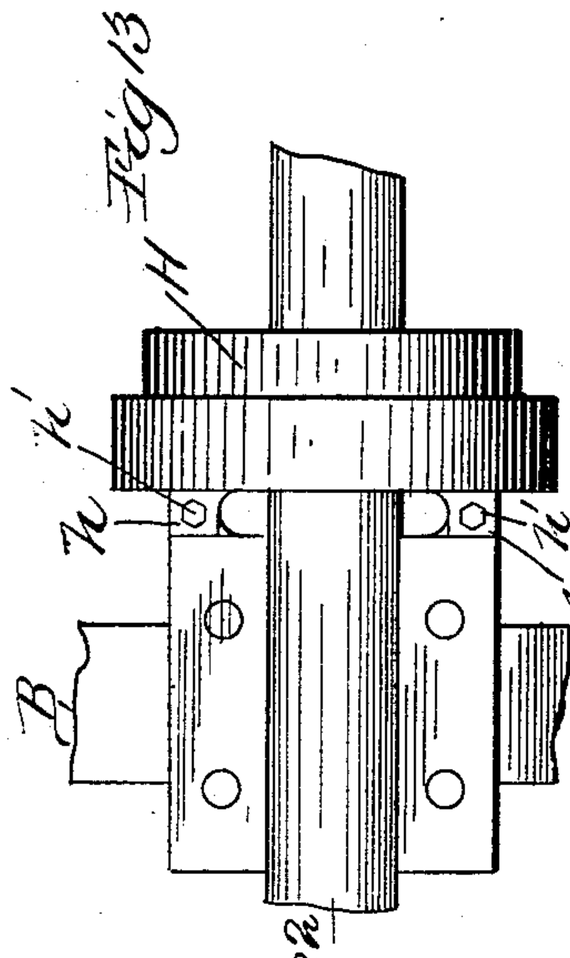

Fig. 13

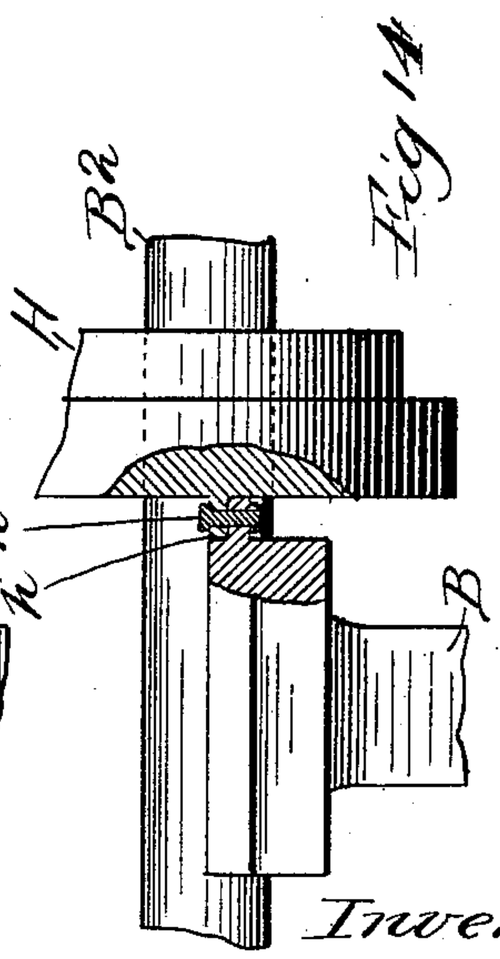

Fig. 14

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UNITED STATES PATENT OFFICE.

WILLIAM SMITH, OF MARIETTA, OHIO, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO LONGFELLOW BROS. AND ROBERT STEPHENS, OF MACKSBURG, OHIO.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 602,630, dated April 19, 1898.

Application filed April 22, 1897. Serial No. 633,302. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM SMITH, of Marietta, in the county of Washington and State of Ohio, have invented certain new and useful Improvements in Rotary Engines; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in rotary engines of that class having a plurality of cylinders surrounding a stationary shaft, said cylinders being connected together so as to revolve about the shaft and being provided with pistons which are operatively connected with said shaft and through the medium of which the cylinders are rotated when a suitable motive power is applied to said pistons. A suitable shaft is connected with said cylinders so as to be rotated thereby when the said cylinders are caused to revolve about said stationary shaft, and said rotative shaft may be provided with a suitable power-wheel, by means of which the power generated by the engine may be transmitted to a point of application.

The invention is herein shown as embodied in a rotary steam-engine; but it will be obvious that the essential features thereof may be applied to engines which are designed to be propelled by other motive agents.

The invention consists in the matters hereinafter set forth, and more particularly pointed out in the appended claims.

In the accompanying drawings, Figure 1 is a longitudinal vertical section of a rotary engine embodying my invention. Fig. 2 is an end view of the same, looking toward the end to which the steam-chests are attached. Fig. 3 is a section taken on line 3 3 of Fig. 1, looking in the direction indicated by the arrows. Fig. 4 is a section taken on line 4 4 of Fig. 1, looking in the direction indicated by the arrows. Fig. 5 is a detail section taken on line 5 5 of Fig. 2. Fig. 6 is a side elevation of the steam-disk and eccentric. Fig. 7 is a detail section taken on line 7 7 of Fig. 1 and looking downwardly. Fig. 8 illustrates the means for reversing the engine. Fig. 9 is a detail section taken on line 9 9 of Fig. 8. Fig. 10 is a section taken on line 10 10 of Fig. 9. Fig. 11 is a section taken on line 11 11 of Fig. 1, showing the covering-plates removed from the outer ends of the steam-chests and steam-cylinders. Fig. 12 is a similar view showing the covers of said cylinders and steam-chests in position. Fig. 13 is a plan view of the right-hand pillow-block shown in Fig. 1 with the top cap removed and showing the manner of securing the steam-disk rigidly thereto. Fig. 14 is a side elevation of the parts shown in Fig. 13, partly in section.

As shown in said drawings, A designates the base of the engine, consisting in this instance of an oblong plate upon which are mounted vertical pillow-blocks B B′.

C designates as a whole a cylindric casing within and upon which are mounted the operative parts of the engine. Said casing consists generally of a short open-ended cylinder comprising an end wall C′, which is herein shown as of considerable thickness, and an integral circumferential wall or rim C^2. The open end of said cylindric casing is closed by means of a removable end wall or plate C^3, which will be secured in place upon the circumferential wall C^2 in any suitable manner, as by tap-bolts. (Not shown.) A rotative shaft D is mounted upon the pillow-blocks B′ B′ to turn therein and is provided between said blocks with a power-wheel D′, through the medium of which power is transmitted to the point of application. Said shaft is rigidly keyed to the end plate or wall C^3 of the cylindric casing C, so as to rotate with the casing and to thereby turn the wheel in an obvious manner. A second shaft B^2 is mounted in the pillow-block B, so as to be normally stationary therein, but which may be rotated, as hereinafter to be described. Said shaft extends inwardly through an opening in the hub of the integral end wall or plate C′ of the casing and is provided within the casing with an integral crank-arm B^3 and a crank-pin B^4, with which the pistons, hereinafter to be described, are operatively connected. The inner face of the end wall C′ of the casing is provided with an annular recess *c*, the purpose of which is to obviate to the largest possible extent friction between the said wall and crank-arm B^3.

E E designate steam-cylinders, which are herein shown as four in number and as cast integral with the walls C′ C² of the casing. Said cylinders are disposed upon the quarters of a circle and extend radially inward toward the shaft B² and are herein shown as made open at their inner ends. The space within the casing between said cylinders may be made solid; but for the purpose of lightening the engine I prefer to core the same and to make it hollow, as herein shown. Said cylinders are also made open at their outer ends adjacent to the periphery of the cylindric casing, but are adapted to be closed by means of plates E′, herein shown as secured thereon by tap-bolts *c*′, passing therethrough and into the side walls C′ C³ of the casing C. If found necessary or desirable, a suitable packing may be interposed between said plates and the outer ends of the circumferential walls of the cylinders to form steam-tight joints.

F F designate pistons mounted to reciprocate in said cylinders E. Said cylinders are herein shown as of the single-acting type, and the piston travels approximately the full length of the cylinders, which are, as before stated, open at their inner ends. Said pistons F are provided with piston-rods F′, pivotally connected thereto by means of an inwardly-projecting integral stud *e* and attached at their inner ends to the crank-pin B⁴ of the shaft B² in any suitable manner to permit of the necessary oscillatory movement of the same in the rotation of the engine. Said pistons are herein shown as of concave form on their inner sides to permit of the oscillatory movement of the piston-rods F′. In the present instance the piston-rods are connected with the crank-pin B⁴ by means of a sleeve B⁵, mounted upon said pin and provided intermediate its ends with an annular disk or plate B⁶. Said disk is provided throughout a greater portion of its circumference with a peripheral groove within which the inner ends of the piston-rods F′ are pivoted by means of pivot-pins *b*. One of the piston-rods F′, as shown in Fig. 4 the one connected with the upper piston, has a rigid connection with said disk or plate B⁶. In this instance the inner end of the rod is screw-threaded and has engagement with a screw-threaded aperture in the periphery of said disk. This construction is designed for the purpose of rendering the connections of the inner ends of the piston-rods with the sleeves B⁵ more stable than would be true if all of the rods had pivotal engagement therewith. The connections of the other rods to the sleeve are such as to permit said rod to maintain a constant angular relation with said plate or disk in the revolution of the cylinders about the shaft B².

G G designate steam-chests secured upon the outer face of the end wall C′ of the casing and located upon said wall adjacent to and opposite the locations of the cylinders E within the casing. Said steam-chests are herein shown as cast integral with the said end plate C, the plate forming the inner walls of said chests. The outer end walls G′ of the chests are, however, made removable and are secured in place by means of tap-bolts *g* passing therethrough and into suitable enlargements *g*′ in the upper ends of the walls of said chests. Each of said chests is normally in open communication with the adjacent cylinder E by means of a passage G³, formed through the end wall C′ of the casing. Said passage opens into the cylinder E, at the outer end thereof, and extends laterally for a short distance toward the chest, from whence it turns obliquely downwardly and enters the steam-chest slightly above the middle thereof, by means of which live steam may pass from the chest to the cylinder E behind the piston F. Said passage also serves as an exhaust-passage for said cylinder upon the upward stroke of the piston, as will hereinafter more fully appear.

Means for supplying steam to the steam-chests G are provided through the medium of passages G⁴, formed in said end wall C′ of the casing. Said passages open into the lower end of the steam-chests G, from whence they extend radially inward toward the hub or center of the plate C′ and open at their lower ends in the outer face of said plate adjacent to the shaft B², where they may have either constant or intermediate connection with a suitable pipe leading from the source of steam-supply. G⁵ G⁵ designate exhaust-passages connected at their upper ends with the steam-chests G, adjacent to the opening of the passage G³ into said chests. From this point said passages extend laterally a short distance toward the cylinders, from whence they turn radially inward, extending between said cylinders and the inlet-passage G⁴ and parallel with said passages, and open into the outer face of the plate a short distance below the opening of said inlet-passage G⁴. Suitable exhaust-pipes will be connected with the exhaust-passages at this point, by means of which the exhaust-steam may be carried from the engine.

In the present instance means for connecting the steam supply and exhaust pipes with the supply and exhaust passages G⁴ G⁵ are provided through the medium of a non-rotative disk or plate H, mounted on the shaft B², with its inner face in close contact with the outer face of the hub of said plate C′, which parts will be so finished as to form a steam-tight joint between the same. As herein shown, said plate C′ is provided on its outer face with a ring B⁷, cast integral therewith, and the inner side of said disk is formed to fit within the space inclosed by said ring. Said disk is provided on its inner side with two concentric grooves H′ H², so formed as to register with the inner ends of the supply and exhaust passages G⁴ G⁵, respectively. Said disk is provided with steam inlet and exhaust passages H³ H⁴, which extend there-

through and are in open communication at their inner ends with said concentric grooves H′ H² on the inner face thereof. It will be seen that with the construction described the steam-chests G will be at all times in open communication with the steam-supply pipe leading from the source of supply through the passage H³, groove H′, and passage G⁴, and therefore the steam in said chests will be at all times at boiler-pressure. The passages G⁵ will be at all times in open communication with the exhaust-passages H⁴ through the annular groove H² at the inner end thereof; but it is not adapted to communicate at its upper end with the interior of the steam-chest. The upper end of said exhaust-passage is, however, designed to have intermittent communication with the cylinders E through the passages G³, said communication being effected by means of a sliding valve, as will hereinafter be more fully described, and by means of which the exhaust-steam of the engine will be carried away from the cylinder.

Means for regulating the supply of steam from the steam-chests to the cylinders are provided as follows:

I I designate sliding or piston valves mounted to reciprocate in the steam-chests G. Said valves bear closely at their inner faces against the outer face of the plate or end wall C′ of the casing adjacent to the openings of the inlet and exhaust passages G³ and G⁵. The inner faces of the valves and the adjacent faces of the plate are dressed to form steam-tight joints between the same, and the parts will be so arranged as to maintain the valve-blocks in close contact with said plate C′. This may be accomplished by providing the block with suitable guides, which engage the inner walls of the steam-chests on the side opposite the faces of said blocks, or the valve-stems by means of which the valve is reciprocated may be made of sufficient strength to provide against lateral movement of said blocks. Said blocks are provided with convex faces which engage concave seats on the adjacent inner surface of the steam-chests G. If desired, however, the blocks may be provided with flat faces and the seats therefor correspondingly formed. Said valve-blocks I I are provided on their inner faces adjacent to the openings of the passages G³ G⁵ with recesses I′, Fig. 1, and the construction of the block is such that said recesses are entirely cut off from communication with the interior of the chest. Said recesses are of sufficient length to extend from the inner side of the mouth of the exhaust-passage G⁵ to the outer side of the inlet port or passage G³, as clearly seen at the lower side of Fig. 1 of the drawings, so that it forms in effect a passage by means of which said steam-passages G³ and G⁵ are connected when the blocks are in the position shown at the lower side of Fig. 1. Said piston-valve blocks I will be so actuated that they will be in their lower position, in which the inlet-passage G³ will be uncovered when the adjacent piston F of the cylinder E is at the extreme limit of its outward movement, so that the steam from the steam-chest will be free to enter said cylinder E through the passage G³ to move the cylinder inwardly and thus rotate the engine. It will be evident from an inspection of the drawings that when the steam is admitted between the head thereof and the piston the pressure of the steam will tend to force the cylinders and pistons in opposite directions, and as the pistons are connected with the fixed crank of the shaft B² the cylinder will be forced forward, carrying the rotatable casing with it. The cylinders, owing to their positions about the shaft, will act successively in this manner and cause the continuous rotation of the casing C, within which the cylinders are mounted. Mechanism will be provided by means of which the valve-blocks I I will be moved outwardly as the cylinders revolve about the shaft B², so that when the cylinder shown at the upper side of Fig. 1 has reached the lower limit of its movement the block will be moved outwardly to cut off the steam-supply and to bring the recess therein in position to connect the passage G³ and passage G⁵. At this time the piston F has reached the limit of its inward movement and as it starts on its return movement in said cylinder the steam therein will be free to exhaust through the passage G³, recess I′, passage G⁵, groove H², and passage H⁴ into a suitable exhaust-pipe. (Shown in dotted lines.)

Means for actuating the valve-blocks to control the supply of steam from the steam-chests G to the cylinders E are provided through the medium of valve-stems I², secured to the blocks I in any suitable manner and, as herein shown, by providing said stem with screw-threaded sections which engage interiorly-screw-threaded lugs *i* on said block. Said valve-stems I² pass through suitable stuffing-boxes *i′* in the inner end walls of the steam-chests and extend radially inward toward the shaft B² and have bearing at their inner ends against the periphery of the disk H, the lateral outer half of which is for this purpose formed eccentrically to the shaft B², as clearly seen in Figs. 1 and 2 of the drawings. In order to provide a more perfect contact between the inner ends of said stems I² and the periphery of the disk H, said stems are provided with suitable rollers I³, rotatively mounted upon the inner ends of said stems and which have rolling contact with the eccentric periphery of said disk. The ring B⁷ on the outer face of the plate C′ is provided adjacent to said stems I² with laterally-projecting studs *a*, Figs. 1 and 2, which are apertured for the passage of said stems therethrough and which form guides therefor. As shown in said last-mentioned figures, the stems I² are provided outside of said laterally-projecting studs *a* with shoulders *i²*, adjustably secured on said stems by means of set-screws *i³*, and between which and the inner ends of the stuff-

ing-boxes i' are mounted spiral expansion-springs I^4. Said springs act to maintain the valve-blocks in their inner position, as shown at the top of Fig. 1, when the inner ends of the valve-stems are engaged with the lowest portion of the eccentric. As the casing C and cylinders therein revolve about the shaft B^2 the inner ends of the valve-stems are gradually forced outward by the action of the cam-surface of the disk H until in the position seen at the lower part of said Fig. 1, when the valve-stem is at the inner limit of its movement and spring at its highest tension. As the engine completes its revolution and the eccentricity of the disk decreases the spring I^4 acts to gradually restore the valve-block to its inner position. As before stated, said shoulders i^2 are adjustable upon the valve-stems, which may be moved thereon to adjust the tension of the spring I^4, as desired. From the above it will be obvious that the speed of the engine may be varied as the tension of the springs I^4 is adjusted from a lower to a higher degree. For instance, if the tension of the spring is increased said spring will act to more promptly restore the valve-block to its inner position as the inner end of the stem moves from the higher to the lower part of the eccentric and thus more promptly allow the admission of steam from the steam-chest G to the cylinders E, with a consequent increase in the action and speed of the engine. On the other hand, if the springs are relaxed to their lowest tension the action of the valve will be less prompt and the speed of the engine therefore reduced. Said sliding piston-valve blocks I will serve also as centrifugal governors, as such blocks are of such weight and the spring I^4 will be so adjusted that when the engine is running at greater than a predetermined speed the blocks will be caused to slide outwardly by the centrifugal force generated thereby and partially close the steam-inlet passages G^3 and thereby limit the supply of steam to the cylinder through said passages. The springs I^4 will be adjusted to the required tension to provide for the proper action of said valve-blocks I under the centrifugal force of the engine. It may be desirable to provide additional weights on the valve-stems I^2 to give the required movement of the block when the springs I^4 have been adjusted to a high tension, and in such event weights I^5 (shown in the detailed view of Fig. 15) will be attached to the rod adjacent to or upon the nut i^2 thereof. It will be understood that said weights will be made removable, so that they may be detached from the rods in case the engine is to be run at a low rate of speed or for any other purpose. Said valve mechanism serves, therefore, the double purpose of positively opening and closing the steam-inlet ports to the cylinders and also regulating the supply of steam therethrough by their centrifugal action. The arrangement of the valve mechanism described furthermore enables one or more of the valves and the cylinder or cylinders connected therewith to be thrown out of action and the engine to be operated by a number of cylinders less than the whole. This may be accomplished by securing in any suitable manner the valve-stem I in its outermost position, in which the inner end thereof will not come in contact with the periphery of the actuating-eccentric in the rotation of the latter. Such arrangement is a desirable one when the engine is to perform light work or work in which the combined powers of the entire number of cylinders will not be required, as it enables such work to be more economically done.

In Figs. 8, 9, and 10 is shown means for reversing the direction of movement of the engine. As shown in said figures, J designates a lever mounted rigidly on the end of the normally stationary shaft B, to the inner end of which the crank-arm B^3 is attached. Said lever is herein shown as provided on its inner end with a short sleeve J', which is slid over the end of the shaft B^2 and keyed or otherwise rigidly secured thereon. Any other suitable means may be employed, however, for rigidly attaching said lever to the shaft. J^2 designates a segment which is secured to a stationary part of the engine, as herein shown to the lower part of the head of the pillow-block, in which the shaft is mounted. Said segment is provided adjacent each end thereof with an aperture extending therethrough, and the lever is provided with a similar aperture which registers with the aperture of the segment when it is in its lower position adjacent to either end of the segment. Said apertures are suitably shaped to receive a key J^3, provided with a web or bit J^4. When the lever is in the position shown in Fig. 2, the key is thrust through said apertures and turned, so that the web or bit is out of the plane of the apertures, when it will be prevented from being withdrawn and the lever locked in place. When the lever J is in the position shown in Fig. 2, the pistons F will be in the position shown in Fig. 4, and the engine, when steam is admitted to the cylinders, will rotate in the direction indicated by the arrow. When the lever is turned and locked to the opposite end of the segment J^2, the crank-arm B^3 will move through one-half of a revolution and thereby shift the pistons within the cylinders, so that steam will act upon the pistons to reverse or move the engine in the opposite direction.

The disk H, as above stated, is mounted on the shaft B^2 so as to normally have no movement with relation thereto, but so constructed that the shaft may be turned within the same. It is desirable, therefore, to secure said disk so that it will not be accidentally displaced or turned on the shaft. In Figs. 13 and 14 is shown a convenient means for accomplishing this result. In said figures the disk H is provided on its outer face, on each side thereof, with an outwardly-extending lug h, which

is adapted to fit upon a correspondingly-shaped inwardly-extending lug on the adjacent head of the pillow-block B. The bolts *h'* pass through said lugs, which secure the said disk and block from movement with relation to each other.

K designates an axial passage extending through the shaft B, and which serves as a vein by means of which oil may be fed therethrough to the crank-shaft and the connection thereof with the piston by any suitable means.

While I have herein shown what I deem to to be a practical embodiment of my invention, it will be understood that many changes may be made in the details thereof without departing from the spirit of the invention. I do not wish to be limited, therefore, to the construction herein set forth except as made the subject of specific claims.

I claim as my invention—

1. A rotary engine comprising a stationary shaft, a cylinder, a piston in said cylinder provided with a piston-rod which is attached at its inner end to said shaft by means permitting revolution of the cylinder about the shaft, said cylinder being provided with an inlet-port and a slide-valve, an eccentric rigid with said shaft, a valve-stem connected at one end with said valve and engaging at its opposite end the periphery of said eccentric, said valve and stem being constructed and arranged to act as a centrifugal governor to cut off the supply of motive agent to said port when the cylinder revolves about the shaft at a greater than a predetermined speed.

2. A rotary steam-engine comprising a stationary shaft, cylinders located about said shaft, pistons in said cylinders provided with piston-rods which are attached at their inner ends to said shaft by means permitting revolution of the cylinders about the shaft, steam-chests on said cylinders provided with ports connecting the same with the cylinders, slide-valves in said steam-chests adapted to control the passage of steam through said ports, an eccentric rigid with said shaft, radially-extending valve-stems attached at their outer ends to said valves and independently engaging at their inner ends the periphery of said eccentric, said valves and valve-stems being arranged so that each may be independently moved out of contact with the eccentric to cut off steam from the cylinder controlled thereby.

3. A rotary steam-engine comprising a stationary shaft, cylinders located about said shaft, pistons in said cylinders provided with piston-rods which are attached at their inner ends to said shaft by means permitting revolution of the cylinders about the shaft, steam-chests on said cylinders provided with ports connecting the same with the cylinders, slide-valves in said steam-chests, an eccentric rigid with said shaft, valve-stems attached at their outer ends to said valves and independently engaging at their inner ends the periphery of said eccentric, springs applied to said stems and means for regulating said springs to vary the tension thereof upon the stems.

4. A rotary steam-engine comprising a stationary shaft, cylinders located about said shaft, pistons in said cylinders provided with rods which are attached at their inner ends to said shaft by means permitting revolution of said cylinders about the shaft, steam-chests on said cylinders provided with ports connecting the same with the cylinders, slide-valves in said steam-chests, an eccentric rigid with said shaft, radially-extending stems attached at their outer ends to said valves and independently engaging at their inner ends the periphery of said eccentric, spiral springs on said stems engaging at their outer ends the inner ends of the steam-chests and each acting to independently control the valve to which it is attached, and means on said stems engaging the inner ends of the springs to regulate the tension thereof.

5. A rotary steam-engine comprising a stationary shaft, cylinders located about said shaft, pistons in said cylinders provided with piston-rods which are attached at their inner ends to said shaft by means permitting revolution of the cylinders about the shaft, steam-chests on said cylinders provided with ports connecting the same with the cylinders, slide-valves in said steam-chests, an eccentric rigid with said shaft, valve-stems attached at their outer ends to said valves, springs applied to said stems, means for regulating said springs to vary the tension thereof upon said stems, and antifriction-rollers interposed between the inner ends of the stems and the periphery of said eccentric.

6. A rotary steam-engine comprising a stationary shaft, cylinders located about said shaft, pistons in said cylinders provided with piston-rods which are attached at their inner ends to said shaft by means permitting revolution of the cylinders about the shaft, said cylinders being provided with steam-ports and with slide-valves for controlling said ports, an eccentric rigid with said shaft, valve-stems attached at their outer ends to said valves and independently engaging at their inner ends the periphery of said eccentric, springs applied to said stems, means for regulating said springs to vary the tension thereof upon the stems, and governor-weights removably secured upon said stems.

7. A rotary steam-engine comprising a non-rotative shaft, cylinders located about said shaft, pistons in said cylinders provided with piston-rods which are connected at their inner ends with said shaft by means permitting revolution of said cylinders about the shaft, steam-chests on said cylinders provided with ports connecting the same with the cylinders, steam supply and exhaust passages opening at their outer ends into said steam-chests, a steam-disk non-rotatively mounted upon the shaft and provided on its inner face with concentric annular grooves adapted to register with the inner ends of said steam supply and

exhaust passages, supply and exhaust pipes opening through said disk and connected with said grooves, and valves in the steam-chests for controlling the supply of steam to and exhaust from the cylinders.

8. A rotary steam-engine comprising a non-rotative shaft, a casing having a solid end wall rotatively mounted on said shaft and provided with a circular recess concentric with said shaft, cylinders mounted on said end wall, pistons in said cylinders provided with piston-rods which are connected at their outer ends with said shaft by means permitting revolution of said cylinders about the shaft, steam-chests on said wall adjacent to said cylinders and connected therewith by means of ports through said wall, steam supply and exhaust ports in said end wall connected at their outer ends with the steam-chests and opening at their inner ends in said annular recess, a steam-disk fitted into said annular recess and provided on its inner face with concentric annular grooves adapted to register with said supply and exhaust ports opening into the recess, supply and exhaust pipes opening through said disk and connected with said annular grooves, and means for controlling the passage of steam from the steam-chest to the cylinders.

9. A rotary steam-engine comprising a stationary shaft, a circular casing provided with a solid end wall rotatively mounted on said shaft, said wall being provided with a central annular recess in its outer face concentric with said shaft, cylinders in said casing, pistons in said cylinders provided with piston-rods which are connected at their inner ends with said shaft by means permitting revolution of the cylinders about the shaft, steam-chests mounted on said wall adjacent to said cylinders and connected therewith by means of passages through said wall, steam supply and exhaust passages in said end wall connected at their outer ends with the steam-chests and opening at their inner ends in said recess of the wall, a steam-disk non-rotatively mounted on the shaft and fitting in said recess of the wall, said disk being provided on its inner face with concentric annular grooves adapted to register with said supply and exhaust passages, steam supply and exhaust pipes opening through said disk and connected with said annular grooves, said exhaust-passages opening into the steam-chests adjacent to the passages leading from the cylinders and a valve for intermittingly connecting said exhaust and cylinder passages and opening said last-mentioned passage for the admission of steam to the cylinder.

10. In a rotary engine, the combination of a stationary shaft and a plate rotatively mounted thereon carrying a cylinder and having ports which lead to the cylinder, a disk removably and non-rotatively mounted on the shaft and provided on its inner face with annular concentric grooves registering with the ports in the plate, supply and exhaust pipes opening through said disk and connected with said grooves and a valve mechanism for controlling the supply of steam to the cylinder, said valve mechanism being engaged with and actuated by said disk.

11. In a rotary steam-engine, the combination of a stationary shaft, a casing rotatively mounted thereon provided with a solid end wall, a cylinder in said casing, a piston in the cylinder connected with said shaft, steam inlet and exhaust ports connected at one end with the cylinder and opening at their opposite ends adjacent to the shaft, a disk non-rotatively mounted on the shaft provided on its inner face with concentric annular grooves adapted to register with said supply and exhaust ports, steam supply and exhaust pipes opening through said disk and connected with said grooves, a valve for controlling the admission of steam to the cylinder provided with an inwardly-extending valve-stem, said disk being formed in its part remote from the annular grooves therein eccentric to the shaft and adapted to engage the inner end of said valve-stem to actuate said valve.

12. In a rotary steam-engine, the combination of a stationary shaft, a casing non-rotatively mounted thereon having an end wall provided with an annular recess or depression concentric with said shaft, a cylinder in said casing, a piston in the cylinder connected with said shaft, steam inlet and exhaust ports connected at one end with said cylinder and at their opposite ends with said recess or depression, a valve for controlling the admission of steam to the cylinder, a disk mounted on the stationary shaft and provided with an inwardly-extending annular flange engaging said recess or depression and on its inner face with concentric annular grooves adapted to register with said steam inlet and exhaust ports, supply and exhaust ports opening through said disk and connected with said annular grooves, the periphery of the part of said disk remote from said grooves being arranged concentrically to the shaft, and a radially-arranged valve-stem connected at its outer end with said valve and adapted to engage at its inner end the periphery of said eccentric.

13. In combination with a rotary steam-engine, embracing a cylinder, a steam-chest thereon, a port connecting the same with the cylinder and an eccentric non-rotatively mounted on the shaft of the engine, of a slide-valve in said steam-chest provided with a radially-extending stem which has engagement at its inner end with the periphery of said eccentric, a shoulder on the stem and a spring applied to said stem to hold the same yieldingly against the eccentric, said valve mechanism being constructed to move outwardly under centrifugal action of the engine to cut off the supply of steam to the said cylinder.

14. In combination with a rotary engine

embracing a cylinder, a steam-chest mounted thereon provided with a port connecting the same with the cylinder and an eccentric non-rotatively mounted on the shaft of the engine, of a slide-valve in said steam-chest provided with a radially-extending stem which has engagement at its inner end with the periphery of said eccentric, said valve being adapted to move outwardly under the centrifugal action of the engine to cut off the supply of steam to the cylinder, a spiral spring surrounding said stem and engaging at its outer end the steam-chest, an adjustable collar on the stem engaging the opposite end of the spring whereby the tension of said spring may be varied as desired.

15. In combination with a rotary engine having a rotative but normally stationary shaft, said shaft being provided with a crank portion, cylinders located around said shaft, pistons in said cylinders provided with piston-rods which are operatively connected with said crank portion of the shaft, of means for turning the shaft so that the pistons will be shifted within the cylinders whereby upon the admission of steam to the cylinders the movement of the engine will be reversed.

16. In combination with a rotary engine having a rotative movement, a normally stationary shaft, said shaft being provided with a crank portion, cylinders located about said shaft and pistons in said cylinders provided with piston-rods which are operatively connected with said crank portion of the shaft, of means for turning the shaft so that the pistons will be shifted within the cylinders, whereby upon the admission of steam to said cylinders the movement of the engine will be reversed, comprising a lever rigidly attached to the shaft, and means for locking said lever to a stationary part of the engine.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 20th day of April, A. D. 1897.

WILLIAM SMITH.

Witnesses:
TAYLOR E. BROWN,
SAMUEL LONGFELLOW.